Clams Hold Story of Ailing Colorado River Delta

BLACKSBURG, Virginia, December 1, 2000 (ENS) - The biological productivity of the Colorado River Delta is just five percent of what it was before the river's water was diverted for human uses. Researchers from the U.S. and Mexico used shellfish to examine the delta's health, pioneering a technique that could be used in other waterways around the world.

Since the 1930s, an environment that supported billions of clams and other life has disappeared because dams and irrigation projects have reduced the flow of nutrient laden fresh water to the tidal flats of the Colorado Delta.

A new approach for measuring life on the delta over the last thousand years, introduced in a study by researchers from four universities, could also be used to estimate the prehistoric productivity of coastal ecosystems in other parts of the world. Such estimates will be especially valuable in areas where no biological surveys were made before humans modified the habitat.

"This effort was highly interdisciplinary," said Michal Kowalewski, a geological scientist at Virginia Polytechnic Institute and State University (Virginia Tech). "We used a variety of tools to combine paleontological, biological, geochemical and satellite image data. It was exciting to find out that we can use fossils to address environmental issues that have direct societal relevance."

Islands composed entirely of gleaming white clam shells line the lower reaches of the Colorado Delta, where the river empties into the Gulf of California between the Baja peninsula and the mainland Mexico. Satellite images and field data indicate that at least two trillion clam shells make up the area's beaches and islands.

Seen from the ground, the shells form miles of sun bleached ridges, originally shaped by spring floods, tides and the passing of generations of abundant shellfish. In the last seven decades, since the river's flow virtually stopped, the clams have become sparse.

"The satellite images told us the area covered by shells, but that by itself doesn't provide a full story," explained Kowalewski. "For instance, do the shells represent a short interval of high productivity, or a long interval of low productivity? Combining satellite data with radiocarbon and amino acid dating shows the changes on the delta."

By dating 125 shells collected from throughout the inter-tidal zone, the researchers learned that essentially all specimens came from the last 1000 years. Every 50 year time period between 950 AD and 1950 was represented among dated specimens, showing that shells were continuously produced in the delta before humans altered the river.

This irrigation canal carries water from the Colorado River to water the vegetable, fruit, and cotton fields of California's Imperial Valley. (Photo courtesy Los Alamos National Laboratory)

The two trillion clam shells washed up onto the delta tidal flats represent 1,000 years of biological productivity. Because shells grow as the animal secrets new layers of material,

the scientists could measure life span of long dead clams by counting the seasonal oxygen isotope cycles in the shell. In the spring, water from snow melt has fewer isotopes.

They learned that the average clam lived three years. So in 1,000 years, there were 333 generations of clams. That means that at any given time there were six billion clams living on the delta, with an estimated density of 50 clams per square meter.

"The mud flats of the Colorado River Delta experience one of the highest tidal ranges in the world - up to 10 meters (about 33 feet). In the past, this macro-tidal system was greatly influenced by the river, but now, at its mouth, the Colorado is more like a channel than a river," said Kowalewski.

The researchers found that where, according to their estimates, there were 50 specimens per square meter in the past (about five per square foot), today there are only three per square meter (about 0.3 per square foot). "These estimates indicate a 20 fold drop in the shellfish productivity in the delta since the river has been diverted by humans," says Kowalewski.

The river's resources are in demand by two nations - the U.S. and Mexico. Since 1981, coordinated efforts have been made to release more water to the delta, as rain and snow melt allow. As a result, there has been partial revival of riparian habitats in the upper delta. In contrast, the study shows that despite the intermittent releases of river water, the benthic - sediment water interface - ecosystems of the lower delta have remained decimated. Just 12 live specimens of Mulinia coloradoensis were found, for example. Yet Mulinia was the most common mollusk in the past, as it represents about 90 percent of the two trillion shells found in the delta.

Even after adding all small mollusks and all shelled nonmollusk macrofauna to life forms being counted, the current density of the benthos - 18 per square meter - is just 36 percent of the density during the times when the river flowed to the delta, according to the report. Since shellfish form a vital part of the food chain in the area and are an important food supply for migratory waterfowl, the revival of benthos is critical to the entire ecosystem.
California clapper rails like this one are among the species endangered by the disappearance of the mollusks. (Photo courtesy California Academy of Sciences)

The techniques used in the study - the integration of paleontological, geomorphologic, geochemical and geochronological data - can be use to determine the original productivity of other waterways. "Almost all big deltas, such as the Nile, Mississippi, or Colorado delta, suffer the effects of human management of the river water," said Kowalewski. "If we want to restore delta ecosystems to their original state, we have to know what that state was. Our approach can be used to gain insights into the original conditions of the delta and assess the negative consequences of water management."

"The approach can be used almost anywhere because shellfish are common and their shells survive around the surface for hundreds of years," Kowalewski said. "We can now at least approximate original productivity and look at changes in ecosystem diversity. We can use these methods in any system where we have a fossil record containing shell material from the last centuries or millennia - rivers, deltas, coastal zones or marine shelves - to get some idea of the pre-human state of aquatic ecosystems."

The research report by Kowalewski, Guillermo Avila of the Universidad Autonoma de Baja California, Karl Flessa of the University of Arizona, and Glenn Goodfriend of George Washington University will be published in the December issue of the journal "Geology." The research was funded by the Eppley Foundation for Research, the National Science Foundation, and the U.S. Geological Survey.